



*Sector #1*  
*#9*  
PATENT  
450117-03120

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants : Francois PACHET et al.  
Serial No. : 09/808,895  
Filed : March 15, 2001  
For : REAL TIME AUDIO SPATIALISATION SYSTEM WITH  
HIGH LEVEL CONTROL  
Art Unit : 2644

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Signature

July 23, 2001  
Date of Signature

CLAIM OF PRIORITY

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

In support of the claim of priority under 35. U.S.C.  
§ 119 asserted in the Declaration accompanying the above-entitled  
application, as filed, please find enclosed herewith certified  
copies of EP Application Nos. 00 400 749.8 and 01 400 401.4,  
filed in EP on 17 March 2000 and 15 February 2001, respectively,  
forming the basis for such claim.

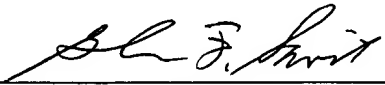
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PATENT  
450117-03120

Acknowledgment of the claim of priority and of the  
receipt of said certified copy(s) is requested.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP  
Attorneys for Applicants

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Enclosure(s)

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Bescheinigung

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Attestation

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The attached documents  
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Patentanmeldung Nr. Patent application No. Demande de brevet n°

00400749.8

Der Präsident des Europäischen Patentamts;  
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**Blatt 2 der Bescheinigung**  
**Sheet 2 of the certificate**  
**Page 2 de l'attestation**

Anmeldung Nr.:  
Application no.: 00400749.8  
Demande n°:

Anmeldetag:  
Date of filing: 17/03/00  
Date de dépôt:

Anmelder:  
Applicant(s):  
Demandeur(s):  
Sony France S.A.  
75831 Paris Cedex 17  
FRANCE

Bezeichnung der Erfindung:  
Title of the invention:  
Titre de l'invention:

Real time audio spatialisation system with high level controls

In Anspruch genommene Priorität(en) / Priority(ies) claimed / Priorité(s) revendiquée(s)

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Internationale Patentklassifikation:  
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## REAL TIME AUDIO SPATIALISATION SYSTEM WITH HIGH LEVEL CONTROLS

### Description

5       The present invention relates to a system by which a listener (user) can control the spatialization of sound sources (also called «tracks») in real time, to produce a spatialized mixing (so-called multi-channel sound) which satisfy a set of so-called «constraints», defined a priori, and stored in the audio file.

As an audio version, MusicSpace provides a high level command  
10   language for moving groups of related sound sources, and may be used to control arbitrary spatialization systems. MusicSpace was connected successfully to a Midi Spatialization system for playing midi files, to a midi-controlled audio mixing console for mixing multi-track recordings, as well as to Ircam's spatialization system (Jot, J.-M. and Warusfel, O., "A Real-Time  
15   Spatial Sound Processor for Music and Virtual Reality Applications", Proceedings of ICMC, 1995. These authors also filed several patent applications about sound spatialization). In all these cases though, MusicSpace is used as a control system, not as a spatialization system *per se*.

There was recently built a specific Dynamic Link Library (dll) for  
20   Window-based PCs which allows MusicSpace to control Microsoft *DirectX* 3D sound buffers. This dll of MusicSpace-audio basically provides a connection between any Java application and DirectX, by converting DirectX's API C++ types into simple types (such as integers) that can be handled by Java.

25       In order to achieve the above-mentioned object, there is provided a method of spatializing sound sources so as to produce a spatialized mixing in real time, the method comprising the steps of:

a) providing an audio carrier including music titles, each of the music titles having a set of specific constraints; and

b) dynamically mixing the sound sources through a decoding module, so that the set of constraints are always satisfied.

5 Typically, the above method further comprises the step of providing the audio carrier from individual audio tracks and a database through an encoding module.

In the present invention, there is also provided a system adapted to implement the above-described method, the system comprising a general-  
10 purpose computer.

Although DirectX may arguably not be the more accurate spatialization system around, this extension has a number of benefits.

First, DirectX provides parameters for describing 3D sound sources which can be constrained using MusicSpace. For instance, a *DirectX* sound  
15 source is endowed with an orientation, a directivity and even a Doppler parameter. An «orientation» constraint has been designed and included in the constraint library of MusicSpace. This constraint states that two sound source should always «face» each other: when one source is moved, the orientation of the two sources move accordingly.

20 Second, DirectX allows to handle lots of sound sources in real time. This is useful for mixing complex symphonic music, which have often dozens of related sound sources.

Lastly, the presence of DirectX on a number of PC makes MusicSpace easily useable to a wide audience.

25 More precisely, the invention allows to:

- Listen to music recorded on a single audio support such as DVD, CD-ROM or Super CD audio, (not exclusive)

- Perform dynamic *audio* mixing, i.e. mixing of audio tracks in real time.
- Use *high level* operators to control this mixing.
- in such a way that a set of «constraints» are always satisfied, this set of constraint being specific for each music title.

5       The present invention is also based on a previous European Patent Application No. 98401266.6, entitled «Mixer using constraint propagation», concerning the underlying constraint technology for relating sound sources together.

The originality of this present invention lies in :

- 10    1) Coding and decoding of multiple audio sources from a single support (e.g. CD-ROM), and therefore explicit handling of audio sources (the previous patent application focused on the Midi format).
- 2) Introduction of high level control, on top of the audio source layer.

15       The above and other objects, features and advantages will be made apparent from the following description of the preferred embodiments, given as non-limiting examples, with reference to the accompanying drawings, in which Fig. 1 illustrates the general data flow of the invention.

Specifications of modules are summarised as follows:

1) Audio and metadata encoder

20       This modules takes as input:

- a) a set of individual audio tracks (monophonic format, all other parameters can be accommodated by the invention, e.g. sampling rate, resolution, etc.,)
- b) a set of metadata, describing the constraints and related constrained variables needed for the constraint system. These metadata are represented in
- 25   a symbolic, textual format.
- c) a format name

The format name must support multiplexed audio data and arbitrary metadata, like: AIFF, WAV, or Mpeg4 (not exclusive).

According to the format name, the module encodes the audio tracks and the metadata into a single file.

5       The specification of the format of the metadata is given infra.

## 2) Audio and metadata decoder

This module takes as input a file in one of the formats created by the encoder.

It recreates:

- a) a set of audio streams from each individual tracks
- 10    b) the specification of the metadata from the encoded format.

The set of audio streams is given as input to the spatialization module.  
The set of metadata is given as input to the constraint system module.

## 3) Constraint System

15       The constraint system is an extension of the constraint system described in previous European Patent Application No. 98401266.6 supra.

The extension consists in:

- Introducing new constrained variables, called «handles». These variables are just constrained variables which are not assigned to a particular audio track. They are constrained by standard constraints already described in previous patent application, or by one-way constraints, described below.
- 20    • Extending the constraint propagation mechanism to include the management of so-called «one-way constraints». This extension of the constraint solver consists in propagating the perturbation in a constraint «only» in the directions allowed by the constraint. More description to come here, including a pseudo-code of one way constraints.
- 25

## 4) Spatialization controller

The spatialization controller module takes as input the following information:

- The set of individual audio streams as decoded by the decoder module.
- Spatialization commands given by the constraint system.

5        This module is identical to the module described in the previous patent application supra, except that there has been designed a specific version for reusing the DirectX spatialization middleware of Microsoft.

      Specifications of the metadata format are as follows.  
each configuration of constraint set is represented by a String as follows:

10        The format contains two parts:

- «variable part»
- «constraint part»

a) Variable part

      Each individual sound track is given a number from 1 to n. Each track  
15    parameter is specified, one by one, in the following order:

- track name,
- track icon,
- individual loudness
- initial position (x, y coordinates)
- 20    • etc...

b) Constraint part

      Each constraint is represented by the following information:

- constraint type,
- constrained variables (numbers of individual tracks)
- 25    • constraint position
- constraint orientations

- etc...

The invention has applications also outside the field of spatialization. It can be used for any situation where:

- 1) Streams of real time data can be controlled by discrete parameters (e.g. streams of audio sources controlled by distance, pan, directivity, etc.),
- 2) Relations between these parameters can be expressed as constraints or combinations of constraints.

Such situations occur frequently in music composition, sound synthesis, and real time control. Only some of them were described supra.

10 Other applications in progress concern the automatic animation of sound sources (e.g. defining sources which revolve automatically around other sources, or which move through a path itself defined with constraints).

**Claims:**

1. A method of spatializing sound sources so as to produce a spatialized mixing in real time, said method comprising the steps of:

a) providing an audio carrier including music titles, each of said music  
5 titles having a set of specific constraints; and

b) dynamically mixing said sound sources through a decoding module, so that said set of constraints are always satisfied.

2. The method according to claim 1, said method further comprising the step of providing said audio carrier from individual audio tracks and a  
10 database through an encoding module.

3. A system adapted to implement the method of claim 1 or 2, comprising a general-purpose computer.

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**Abstract**

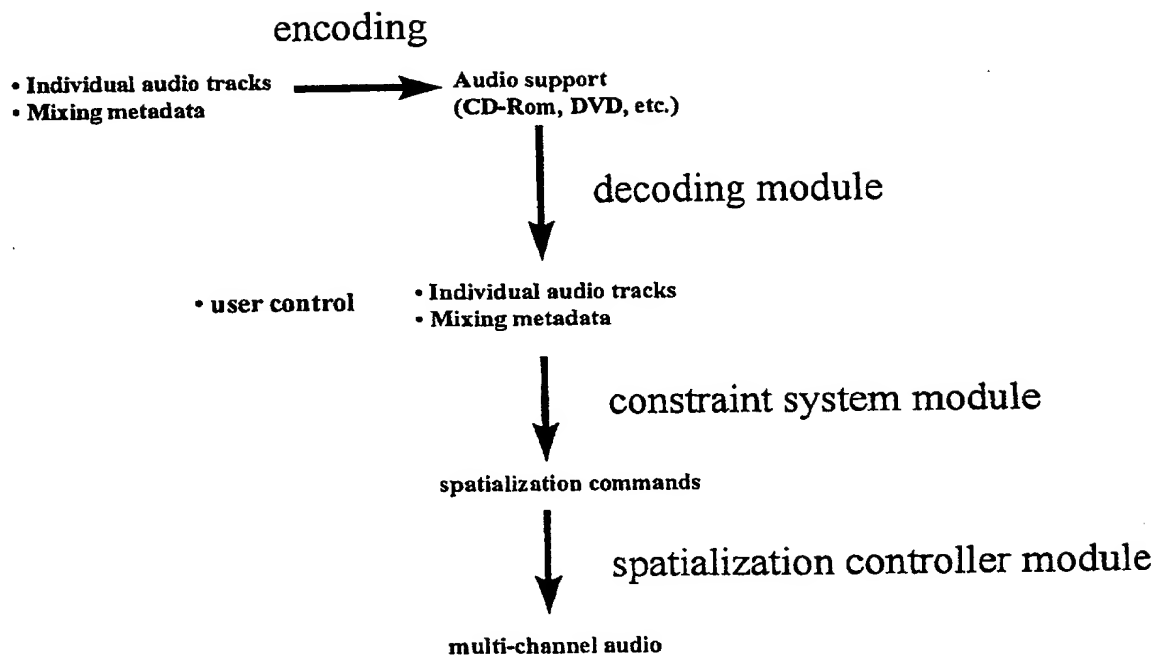
The invention relates to a system in which a user can control the spatialization of sound sources in real time, and produce a spatialized mixing. In this system, the user listens to a music recorded on a single audio support such as DVD or CD-ROM, and performs dynamic audio mixing under high-level controls. To enable the above operation, each music title is provided with a set of specific constraints, and the dynamic audio mixing must satisfy the set of constraints.

FIG. 1

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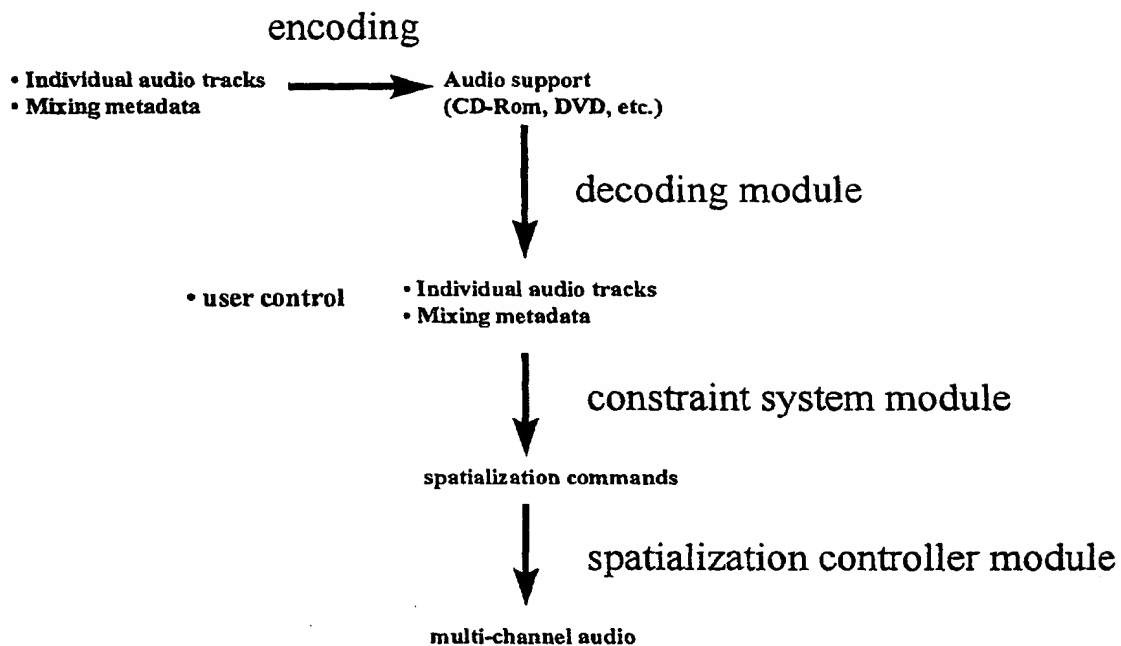
FIG. 1

**General dataflow of invention**

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## ABSTRACT

FIG. 1



General dataflow of invention

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